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Letter to Editor

A Promising Approach for Pancreatic Cancer Therapy: Integrating Artificial Intelligence, Oncolytic Virotherapy, Probiotic Therapy, Stem Cell Therapy, and Immunotherapy

Piruz Shadbash [1,2*], **Marzieh Bahari Babadi** [3]

[1] Basic and Molecular Epidemiology of Gastrointestinal Disorders Research Center, Research Institute for Gastroenterology and Liver Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Department of Microbiology and Microbial Biotechnology, Faculty of Life Sciences and Biotechnology, Shahid Beheshti University, Tehran, Iran
[3] Department of Biochemistry, Medical School, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

Corresponding Author: Piruz Shadbash, PhD Candidate, Basic and Molecular Epidemiology of Gastrointestinal Disorders Research Center, Research Institute for Gastroenterology and Liver Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Tel: +989366522792, E-mail: shadbashpiruz@gmail.com

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Dear Editor

Pancreatic cancer (PC) remains one of the most aggressive and lethal malignancies worldwide, with a five-year survival rate below 12% despite advances in conventional treatments.[1] The urgent need for novel, synergistic, and personalized therapeutic strategies has led to growing interest in combining cutting-edge technologies such as Artificial Intelligence (AI), oncolytic virotherapy, probiotic therapy, stem cell-based therapy, and immunotherapy. This integrative approach represents a promising horizon for improving diagnostic precision, therapeutic efficacy, and patient outcomes in PC. AI serves as an integrated platform that combines patient-specific omics, imaging, immunology, and microbiome data.[2] Machine learning algorithms, such as LASSO and random forest, are then utilized to identify key predictive features and suggest personalized treatment pathways.[3,4] This includes the delivery of oncolytic viruses to specific tumor pathways, therapeutic drugs by stem cells to targeted tumor sites, tailored immunotherapies based on checkpoint expression and immune profiles, and optimized probiotics to modulate the immune-microbiome axis.[5] Through reinforcement learning simulations, clinicians can predict the outcomes of combination therapy and use this information to tailor approaches that maximize efficacy while minimizing toxicity.[6] Artificial Intelligence has revolutionized the early detection and treatment planning of pancreatic cancer by enabling high-throughput analysis of radiological, histopathological, and genomic data.[7] Machine learning algorithms can identify subtle imaging biomarkers for early diagnosis, predict treatment responses, and personalize therapeutic regimens.[3,8] Moreover, AI-driven drug discovery accelerates the identification of novel targets and the optimization of combination therapies that may overcome chemoresistance in PC.[9] Recent quantitative radiomics studies have shown that AI-assisted imaging models can achieve high diagnostic performance in differentiating pancreatic tumor subtypes. For example, one study using a CT-based radiomics model reported an Area under the Receiver Operating Characteristic Curve (AUC) of 0.884 for differentiating Non-Functional Pancreatic Neuroendocrine Tumor from Pancreatic Ductal Adenocarcinoma,[4] while another achieved an AUC of 0.994 for classifying pancreatic cystic lesions.[10] Similar studies achieved AUCs above 0.95 using a fusion of radiomics and clinical biomarkers.[11,12] These data indicate the growing quantitative impact of AI in the noninvasive diagnosis of pancreatic cancer. Oncolytic virotherapy, which uses genetically engineered viruses to selectively infect and lyse tumor cells while stimulating anti-tumor immunity, has shown substantial promise.[13] Engineered viruses such as adenoviruses, reoviruses, and vaccinia viruses not only directly destroy cancer cells but also enhance immune recognition of tumor-associated antigens.[14] When combined with immunotherapies like checkpoint inhibitors, these viruses may help overcome the highly immunosuppressive tumor microenvironment characteristic of pancreatic adenocarcinoma.[14] Probiotic therapy represents an emerging adjunct in cancer treatment by modulating the gut–pancreas axis and immune regulation.[15] Specific bacterial strains have demonstrated the potential to reduce inflammation, enhance immune responses, and improve the efficacy of immunotherapies.[16] Similarly, mesenchymal stem cells (MSCs) offer a dual advantage through their tumor-homing capabilities and their ability to deliver therapeutic agents directly into the tumor milieu.[17] Genetically engineered MSCs can be used to transport

oncolytic viruses, cytokines, or gene-editing molecules specifically to pancreatic tumor sites, minimizing systemic toxicity.[18] Immunotherapy continues to be a key pillar of innovation in PC management.[19] The combination of immune checkpoint inhibitors, cancer vaccines, and adoptive T-cell therapies with AI-guided predictive modeling may refine patient selection and maximize clinical benefit. Integrating these modalities with microbiome modulation and stem cell delivery systems can transform pancreatic cancer from a nearly untreatable disease into a manageable condition.[20] In the coming years, the integration of AI with immunotherapy, stem cell engineering, and microbiome modulation is expected to advance precision oncology in pancreatic cancer. Therefore, the need to develop large, interpretable datasets as well as interpretable AI models will be essential for reliable clinical diagnosis. Future research should also focus on adaptive, AI-based treatment planning that evolves in response to patient-specific biological changes, ultimately transforming pancreatic cancer management into a more predictive and personalized discipline.[21,22] Despite the promising integration of AI with biological and immunological therapies, several challenges remain for clinical application. Current AI models for pancreatic cancer are often trained on limited and outdated datasets that may not adequately represent the complexity and diversity of data.[2] Therefore, the generalizability of models due to changes in imaging protocols and data labeling inconsistencies leads to disruption of standard feature extraction. Ethical concerns are also another perennial challenge in the use of AI.[22] Therefore, the two important principles of data privacy and algorithmic unbiasedness must also be considered before implementing decisions made in clinical settings.[23] In addition, the complexity of combining AI predictions with dynamic biological systems, such as immune modulation and microbiome interactions, poses significant challenges in the way forward.

In conclusion, the convergence of AI, oncolytic virotherapy, probiotic modulation, stem cell engineering, and immunotherapy embodies a revolutionary step toward precision oncology in pancreatic cancer. Collaborative translational research, supported by computational modeling and clinical validation, will be critical in turning these promising concepts into effective therapies capable of improving patient survival and quality of life.

Conflict of Interest Disclosures

The authors declare that they have no conflicts of interest.

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